IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of	: Confirmation No. 4361
Kenji SAITO et al.	: Group Art Unit: 3723
Serial No. 10/532,586	: Examiner: Robert J. Scruggs
Filed: April 25, 2005	

DECLARATION UNDER 37 CFR 1.132

Honorable Commissioner of Patent and Trademarks

Sir:

I, Kenji SAITO declare that:

I was born in Ehime Prefecture, Japan, on April 6, 1952;

I am an inventor of the above-identified US patent Application;

I am a citizen of Japan and a resident of 27-14, Umezono 2-chome, Tsukuba-shi, Ibaraki-ken 305-0045, Japan;

I graduated from Ritsumeikan University, Science and Technology Department, Kyoto-shi, Kyoto-fu, Japan in 1978;

I took the doctor degree on the study of the nuclear physics at Tohoku University, Sendai-shi, Miyagi-ken, Japan in March 1983. My doctoral work dealt the nuclear magnetic structure of ^{24}Mg entitled "Inelastic magnetic transition from ^{24}Mg used 180° electron scattering";

I was appointed as researcher at Japan Society for the Promotion of Science (Nippon Gakujutsu Shinkou-kai) in 1983 and worked for two years 1983-1985 at High Energy Accelerator

Research Organization, 1-1 Oho, Tsukuba-shi, Ibaraki-ken, Japan. I innovated Horizontal Electropolishing Method for superconducting RF niobium cavity there;

I was appointed as associated researcher at High Energy Accelerator Research Organization in 1985. I contributed to the construction of a large superconducting RF accelerator system in the TRISTAN project, which was realized firstly in the world;

I was promoted to assistant professor position at High Energy Accelerator Research Organization in November 2000;

I made concurrently serving the Nagoya University in for one year in 2004. I made lecture there on Superconducting RF cavities for graduate students;

I am concurrently serving the Tokyo University. I am lecturing on Superconducting RF cavities for graduate students since September 2006;

I visited Thomas Jefferson Accelerator Laboratory (JLAB), Newport News, Virginia, U.S.A. during April 1990 to March 1992 as a first guest scientist of JLAB. I was invited by Professor R. Sundelin and worked with Professor. P. Kneisel. I contributed the start-up of CEBAF accelerator construction. I educated CEBAF's engineers and technicians how to assemble cavities in clean-room and to measure them at cryogenic temperature. I developed high gradient SRF cavities with a 30MV/m gradient;

I visited JLAB again in 1994 by short term visiting fellowship of Japanese Ministry of Education and Technology for a half of year in order to study cryogenic refrigerator system;

I studied on the nuclear physics including below 1) to 4);

I switched to accelerator science and technology since

1983 as mentioned above;

The papers below 5) to 118) are on R&D of accelerator.

I reported the following papers up to 2004;

1980 -

1) K.Saito : "Magnetic Multipole Transition of ^{24}Mg by Inelastic Electron Scattering at 180° ", Lecture Notes of 1980 RCNP Kikuchi Summer School, May 12 - 15, 1980, P.227.

2) "Magnetic Multipole Transition in ^{24}Mg by Inelastic Electron Scattering at 180°", Proc. of 1980 RCNP International Symposium on Highly Excited States in Nuclear Reactions, Osaka University, May 12 - 16, 1980, Edited by H.Ikegami and M.Muraoka, P.258.

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1984 -

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8) Takaaki Furuya, Kiyomitsu Asano, Yuzo Kojima, Shinji Mitsunobu, Hirotaka Nakai, Toshiharu Nakazato, Shuichi Noguchi, Kenji Saito and Tsuyoshi Tajima: " The TRISTAN Superconducting Cavities ", Proc. of the 3rd Workshop on RF Superconductivity, ANL, U.S.A., September, 1987, pp.95 - 108.

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1988 -

10) Kiyomitsu Asano, Takaaki Furuya, Yuzo Kojima, Shinji Mitsunobu, Hirotaka Nakai, Shuichi Noguchi, Kenji Saito and Tsuyaoshi Tajima: " XPS and AES Studies of Thin Oxide Layers on Niobium for Superconducting RF Cavities ", KEK Report 88 - 2, 1988.

1989 -

11) Y.Kojima, K.Akai, M.Arinaga, K.Asano, E.Erura, T.Furuya, K.Hara, K.Hosoyama, A.Kabe, E.Kako, Y.Kojima, K.Kobo, S.Kurokawa, S.Mitsunobu, H.Nakai, T.Nakazato, S.Noguchi, T.Ogitsu, K.Saito, Y.Sakamoto, T.Shishido, TSuzuki, T.Tajima and T.Takahashi: " Upgrading of TRISTAN by Superconducting RF System ", Proc. of 1989 Particle Accelerator Conference, Chicago, Illinois, U.S.A., 1989, pp. 1789 - 1791.

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Shuichi Noguchi, Kenji Hosoyama, Toshiharu Nakazato Tsuyoshi Tajima, Kiyoshi Asano, Kigo.Inoue, Yohuske Iino, Hiroshi Nomura and Koichi Takeuchi : " R & D of Superconducting Cavities at KEK ", Proc. of the 4th Workshop on RF Superconductivity, KEK, Tsukuba, Japan, August 14 - 18, 1989, pp.635 - 694.

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15) K.Saito : " Field Limitations in Vertical Test of the KEK 5-Cell Cavities ", Proc. of the first International TESLA Workshop, Cornell Uni., Ithaka, U.S.A., July 23 - 26, 1990.

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Superconducting Niobium Cavities ", Proc. of the IEEE Particle Accelerator Conference, San Francisco, USA, 1991, pp. 2387 - 2389.

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Mapping System Developed at KEK for Field Emission Studies on Superconducting Cavities ", Proc. of the XVth International Conference on High Energy Accelerator Conference, Hamburg, Germany, 1992, pp. 751 - 753.

33) Kenji Saito: " The Future of Surface Treatment Technologies for High Field Niobium Superconducting Cavities ", Proc. of Workshop on AC Superconductivity Sponsored by the Particles and Fields Commission of IUPAP, KEK, Tsukuba, Japan, June 23 - 25, 1992, P. 138 - 147.

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40) J.Halbritter, P.Kneisel, and K.Saito: " Additional Losses in High Purity Niobium Cavities Related to Slow Cooldown and Hydrogen Segregation ", Proc. of the 6th Workshop on RF Superconductivity, CEBAF, Newport News, VA. U.S.A., October 4 - 8,1993, pp. 617 - 627.

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42) E.Kako, S.Noguchi, M.Ono, K.Saito, T.Shishido, S.Kobayashi, M.Matsuoka, H.Miwa, T.Suzuki and T.Higuchi: " HIGH GRADIENT TESTS OF 1.3 GHz SUPERCONDUCTING CAVITIES ", Proc. of the 1994 International Linac Conference, August 21-26, 1994, Tsukuba, Japan, pp. 251 - 253.

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The experiments set out below were conducted under my supervision and direction.

Experiment 1

Comparative investigation on occlusion of hydrogen as a solid solution according to a kind of a liquid medium in centrifugal barrel polishing

(1) Test method

Dehydrogenation of an L band niobium single cell cavity (a length of 370 mm and the maximum diameter of 210 mm) was conducted by applying vacuum annealing at 750°C for 3 hours thereto. Inserted into the cavity was a plate-shaped niobium sample (a thickness of 2.5 mm, a width of 1 mm and a length in the range from 147 to 149 mm, which is also simply referred to as a sample) dehyrogenated in a similar way and thereafter an inner surface of the cavity and the niobium sample were subjected

to centrifugal barrel polishing using Fluorinert$_{TM}$ fluorine containing inert liquid (Fluorinert^{TM}) FC-77 (a mixture of $C_8F_{16}O$ and C_8F_{18}) manufactured by 3M Co. as a liquid medium with a resulted average polishing-off thickness of about 30 μm. Note that a polishing-off thickness of 30 μm corresponds to a thickness of an affected layer on a surface of niobium material to be removed by the polishing judging based on experiments in the past and the rule of thumb. Centrifugal barrel polishing was performed in conditions described in Table 1 with the apparatus shown in Figs. 1 and 2.

Table 1

Rotation number	160 rpm
Revolution number	160 rpm
Polishing chips	GCT
Amount of polishing chips	2000 cm^3
Amount of liquid medium	850 ml
Polishing time	4 hrs

Fig. 1

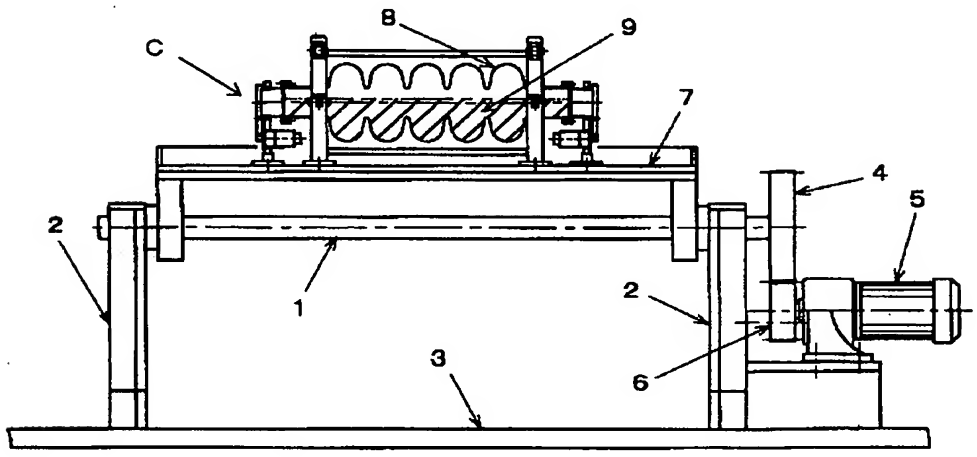
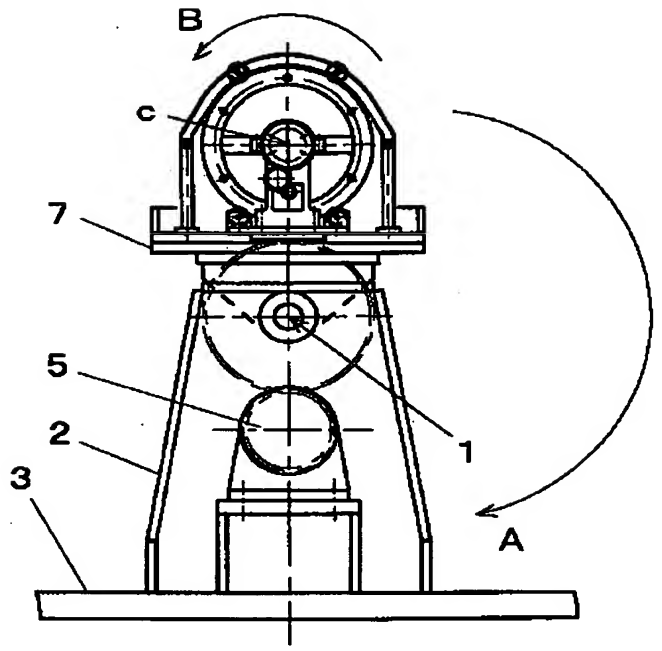


Fig. 2



Note that triangular prism-shaped GCT containing silicon carbide (SiC) as abrasive grains (manufactured by TKX Co.) was adopted as polishing chips. Furthermore, for comparison, prepared from the same material were a sample obtained by centrifugal barrel polishing in a dry condition without using a liquid medium, a sample obtained by centrifugal barrel polishing using a mixture of water and a surfactant as a liquid medium and a sample obtained by centrifugal barrel polishing using a hydrogen peroxide water or absolute propyl alcohol as a liquid medium.

Measurements were conducted on polishing-off thickness of the polished niobium samples and hydrogen concentrations in the samples. A polishing-off thickness was measured with an ultrasonic film thickness meter (manufactured by NOVA Co. with a model 800+). A hydrogen concentration in a sample was measured

with RH-1E method of LECO Co. (a combination of an inert gas melting method and a thermal conductivity method described in JIS-Z-2614).

(2)Test result

Results of the measurements are shown in Table 2.

Table 2

Liquid medium	Hydrogen concentration (detected values: ppm)	Polishing-off thickness (μm)
Water + Surfactant	79.1±5.0	About 30
None (dry)	10.9±0.8	About 0 to 5
Absolute propyl alcohol	49.4±2.2	About 30
Hydrogen peroxide water (10%)	28.4±1.4	About 30
Fluorinert FC-77	4.6±0.8	About 30

An average polishing-off thickness in the range from about 0 to 5 μm in a case of a dry polishing (without a liquid medium) shows almost no polishing-off on the sample in the method. From the results, it was made clear that mechanically polishing with Fluorinert FC-77 having no hydrogen atom in a molecule thereof as a liquid medium greatly suppresses occlusion of hydrogen as a solid solution into a member to be polished in comparison with other liquid media.

Experiment 2

Comparative investigation on occlusion of hydrogen as a solid solution with ozone contained in liquid medium in centrifugal

barrel polishing

(1) Test method

After a plate-shaped niobium sample (a thickness of 2.5 mm, a width of 1 mm and a length in the range from 147 to 149 mm), according to Experiment 1, was put into an L band niobium single cell cavity (a length of 370 mm and the maximum diameter of 210 mm) dehydrogenated by vacuum annealing, the sample was subjected to centrifugal barrel polishing with FC-77 alone or a mixture of FC-77 and ozone in which ozone is absorbed in FC-77, as a liquid medium.

(2) Test result

Hydrogen concentrations (ppm) in samples after the central barrel polishing are as shown in Table 3.

Table 3

Liquid medium	Hydrogen concentration (ppm)	Polishing-off thickness (μm)
FC-77 alone	4.60±0.8	about 30
FC-77 + ozone	2.67±0.5	about 30

From Table 3, it was found that hydrogen concentrations in samples are both low, if they are subjected to centrifugal barrel polishing with FC-77 alone and mixture of FC-77 and ozone, respectively, as a liquid medium, which means that occlusion of hydrogen as a solid solution into the samples was remarkably suppressed during centrifugal barrel polishing.

Experiment 3

Manufacture of niobium superconducting accelerating cavity

(1) Test method

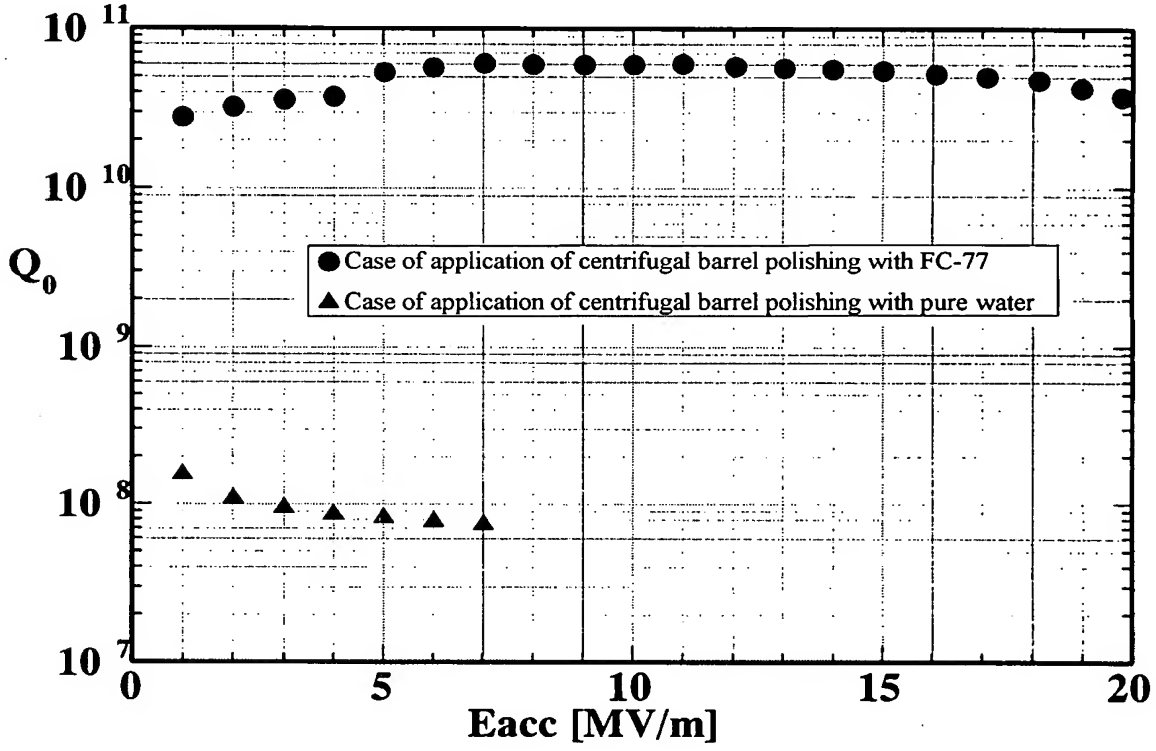
Installed in the apparatus of Fig. 1 was a 1300 MHz single cell cavity with a total cavity length of 370 mm, the maximum cavity diameter of 210 mm, a beam pipe diameter of 80 mm and a thickness of 2.5 mm and the single cell cavity was subjected to centrifugal barrel polishing. Conditions for centrifugal barrel polishing were in conformity with those of Experiment 1 and Fluorinert$_{TM}$ fluorine containing inert liquid (Fluorinert^{TM}) FC-77 manufactured by 3M Co. was employed as a liquid medium. After cleaning with pure water, the cavity was placed on a support table with a rotation activating function and an inverting function, a chemical polishing solution kept at 30°C and composed of 89 w/v % phosphoric acid : 67 w/v % nitric acid : 40 w/v % hydrofluoric acid = 1 vol : 1 vol : 1 vol was continuously fed at a flow rate of 10 L/min through the cavity while the cavity was rotated at 10 rpm, and chemical polishing was thus conducted in the cavity for 10 minutes (a target of polishing-off was 50 μm) as shown in Fig. 2. Thereafter, while the cavity is rotated, the polishing solution was rapidly discharged and, also, rolling and inverting were alternately effected in a repeated manner to clean the cavity by means of a common method. As Comparative Experiment, another single cell cavity was subjected to centrifugal barrel polishing with water only as a liquid medium and then a single cell cavity chemically polished in conformity with the above-mentioned

procedure.

(2) Test result

Total polishing-off thickness values of the cavities of Experiment 3 and Comparative Experiment thus obtained were measured with the result of an average thickness of about 80 μm. Acceleration performances (Q-values and accelerating electric fields [Eacc: MV/m]) of the cavities are shown in Fig. 3.

Fig. 3



Note that a measurement test for an acceleration performance was conducted at 1.4 K to which the cavity was cooled after being held at 100K for 16 hours in order to clearly confirm reduction

in Q-value due to occlusion of hydrogen as a solid solution. Reduction in Q-value was observed with a rise in an accelerating electric field in the cavity of Comparative Experiment obtained in a procedure in which after centrifugal barrel polishing with pure water, chemical polishing was applied, whereas no reduction in Q-value in the cavity of Experiment 3 was observed even with a rise in accelerating electric field. Therefore, it is clear that the accelerating cavity manufactured in Experiment 3 has by far higher acceleration performance as compared with that manufactured in Comparative Experiment.

It is declared by the undersigned that all statements made herein of undersigned's own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and that such willful false statements may jeopardize the validity of the above-identified application or any patent issuing thereon.

This 14 th day of September, 2007

Kenji Saito

Kenji SAITO